Intelligence test solving through eye-movements and mouse-movements

Guillaume Rivollier[1,2],Jean-Charles Quinton[1], Flora Gautheron[1], Annique Smeding[3]

[1] Univ. Grenoble Alpes, CNRS, Grenoble INP, LJK, 38000 Grenoble, France

[2] Univ. Grenoble Alpes, LIP/PC2S, 38000 Grenoble, France

[3] Univ. Savoie Mont Blanc, LIP/PC2S, 73000 Chambéry, France

Raven's Advanced Progressives Matrices

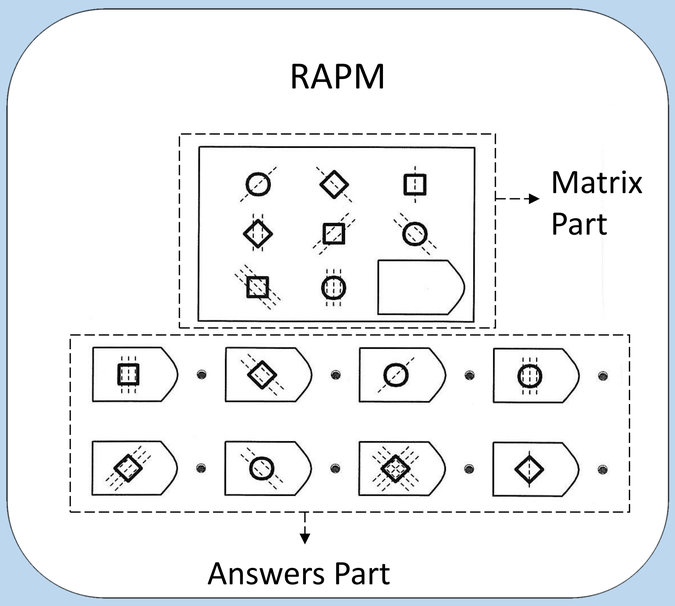
Raven's Advanced Progressives Matrices (RAPM) are common non-verbal psychometric tests used for assess reasoning and fluid intelligence.

Two strategies :

- constructive matching : infere rules and construct a supposed answer, then finding the constructed answer among the proposed responses
- response elimination : Matrix and response features comparison in way of eliminating incorrect answers

Correlation between strategies and performance (Carpenter *et al.*, 1990) **:**

- constructive matching strategie is associated with better score.
- response elimination strategies is associated with lower score.



Previous Results

- Exploration-related **eye movement** indices reflecting strategies correlate with score[1]
- Exploration-related **mouse movement** indices reflecting strategies correlate with score[2]

Indices	Eye Tracking[1] (n = 55)		Mouse Tracking[2] (n = 130)	
Item latency	0.03		0.63	***
Time on Matrix	0.08		0.65	***
Time on alternatives	-0.25		0.29	***
Proportional Time on Matrix	0.48	**	0.56	***
Proportional Time on alternatives	-0.44	**	-0.56	***
Number of toggles	-0.27	*	0.02	
Rate of toggling	-0.43	**	-0.55	***
Latency to First Toggle	0.41	**	0.70	***
Proportional Latency to First Toggle	-------		0.32	***

Correlations between score and exploration-related indices

Although mouse movements add a supplementary cost to switching between elements, the change from eye movements to mouse movements preserves most correlations

[1] From Vigneau *et al.* (2006)

[2] From Rivollier *et al.* (in prep.)

Present study

For this study, we have recruited 85 students for pass 12-items short form of RAPM. Each participant passed the test under one of the four dynamic interfaces. Mouse- and eye-movement were recorded.

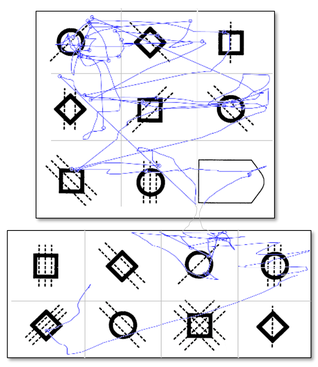
Aims :

- Better understanding of the impact of visual constraints on solving strategies
- Coupling eye tracling and mouse tracking
- Investigate how visual and motor information-selection process coordinate

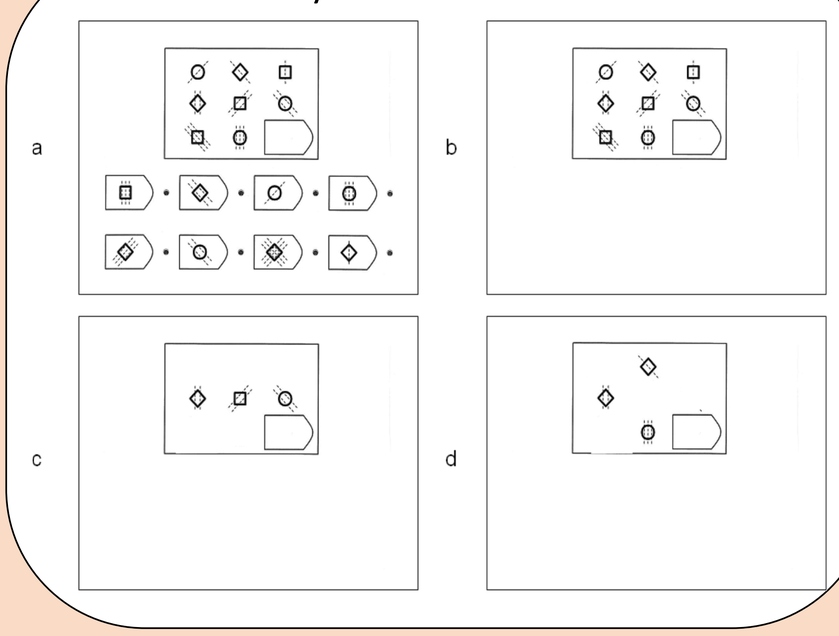
Design :

- Four conditions for the interactions (between-subjet factor) :
  a - **Original** : full matrix and full answers parts visible all the time
  b - **Switch** : full matrix or full answers parts visible by clicking on it
  c - **Line** : one single line of the matrix or full answers part visible by clicking on it
  d - **Sequence** : upto three cells of the matrix or full answers part visible by clicking on it

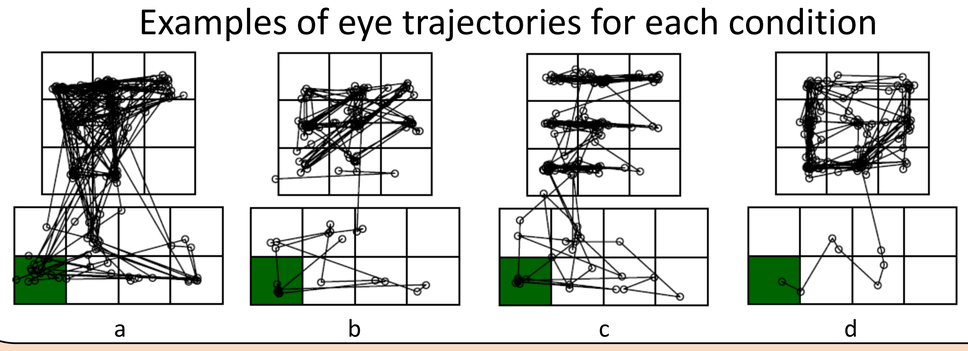
Example of mouse trajectory



Dynamic Interfaces



Examples of eye trajectories for each condition



Planned Analyses

- Similarity between mouse- and eye-exploration sequences (Dynamic Time Warping, Cross-correlation)
- Similarities of indices between interfaces
- Similarities of indices between manual- vs eye-measures

References & Contact

Carpenter, P. A., Just, M. A., & Shell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices Test. *Psychological Review*, *97*(3), 404–431.

Vigneau, F., Caissie, A. F., & Bors, D. A. (2006). Eye-movement analysis demonstrates strategic influences on intelligence. *Intelligence*, *34*(3), 261–272.

Rivollier, G., Smeding A., Bruno, A., Quinton, J-C., Impact of constraints in visual exploration of Raven progressive Matrices.

guillaume.rivollier@univ-grenoble-alpes.fr
@g_rivollier

IDEX - IRS